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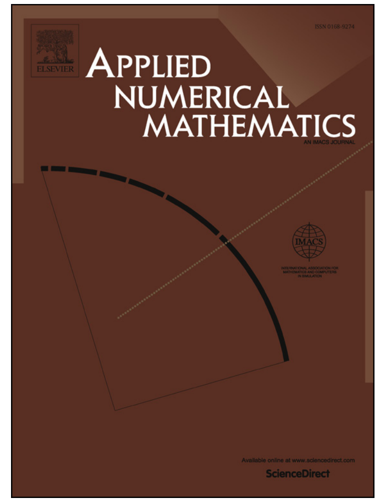

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Convergence and Stability Analysis of Heterogeneous Time Step Coupling Schemes for Parabolic Problems

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Abstract

We propose and rigorously analyze the subcycling method based on primal domain decomposition techniques for first-order transient partial differential equations. In time dependent problems, it can be computationally advantageous to use different time steps in different regions. Smaller time steps are used in regions of significant changes in the solution and larger time steps are prescribed in regions with nearly stationary response. Subcycling can efficiently reduce the total computational cost. Crucial to our approach is a nonstandard heterogeneous temporal discretization. We begin with the discretization in time by the asynchronous Rothe method, which, in essence, involves a backward finite difference scheme assuming different time steps (fine and large time steps) in different parts of the computational domain. The emphasis of the paper is on qualitative properties of the new numerical scheme, such as a-priori estimates, existence of the time-discrete solutions and the strong convergence and stability analysis. Several numerical experiments were conducted to examine the consistency of the proposed method.

Keywords: Parabolic problems, method of Rothe, subcycling, domain decomposition, convergence and stability analysis
2000 MSC: 35K05, 65M12, 65D99

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